Incidence rates and risk factors for asthma among school children: A 2-year follow-up Report from the Obstructive Lung Disease in Northern Sweden (OLIN) studies

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Abstract Studies of incidence of asthma are still limited. A longitudinal study of asthma in school children was started in 1996 in Northern Sweden. The incidence of asthma and the associated risk factors have been studied over a 2 years period. The study started with a parental questionnaire, the ISAAC questionnaire with additional questions, and a skin-prick test. The cohort, 3525 children, 7 and 8 years old at start, was followed after 1 and 2 years by using the same questions. Each year responded 97%. The cumulative incidence of physician-diagnosed asthma was 1.7%, 0.9/1000/year the first year, and 0.8/1000/year the second year. The cumulative incidence of wheezing was 6.3%, and of frequent or daily users of asthma medicines 2.1%. Significant risk factors for incident asthma were a positive skin test, OR 5.64 (3.10–10.25); rhinitis, OR 3.53 (1.80–6.90); eczema, OR 2.19 (1.26–3.82); a family history of asthma, OR 2.83 (1.75–4.56); low birth weight, OR 3.38 (1.61–7.54); respiratory infections, OR 2.12 (1.24–3.63); male gender, OR 1.71 (1.06–2.81); and a smoking mother OR 2.00 (1.07–3.73). In summary, the incidence of asthma during 2 years after age 7 was high, almost 1/100/year. Allergy was the most important risk factor, but other factors were influential.

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Keywords asthma; incidence; prevalence; risk factors; children; prospective study.

INTRODUCTION

Several cross-sectional studies of asthma have been performed worldwide during the last decades reporting increasing prevalence rates, mainly among children and young adults (1–3). The incidence of asthma among young children is high (4–7). Prospective studies of asthma incidence in the general population are still uncommon. In the literature, reported incidence rates among school children range from 1 to 14 per 1000 persons-year (4–9). As a consequence of only few longitudinal studies, the risk factors for asthma, based on incident cases, has poorly been studied.

Asthma is not a homogenous disease (10). The risk factor pattern for allergic and non-allergic asthma differ (11,12), as well as the risk factor pattern for prevalent and incident cases (13). Studies of risk factors for asthma are mainly based on prevalent cases from cross-sectional studies or case–control studies. These methods cause difficulties in separating cause from consequence for factors that may change over time.

Allergic sensitisation (3,8,11–14), rhinitis (6,15), eczema (6) and a history of asthma in the family (3,6,11,15–18) are strongly related to asthma. Environmental factors, such as tobacco smoke (11,16,18,19) and dampness at home (11,16,18) are identified as risk factors for asthma, particularly among small children.

A longitudinal study in progress in Northern Sweden showed in 1996 that 5.7% of children aged 7 and 8 had been diagnosed as having asthma (17). The aim of the present study was to evaluate the incidence of asthma and wheezing during a 2-year follow-up period, and to examine risk factors for incident cases of asthma in this population of school children.

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MATERIAL AND METHODS

In 1996, all children enrolled in the first- and second-grade classes in the municipalities of Kiruna, Luleå, and

Piteå in Northern Sweden were invited to take part in a longitudinal study of asthma and allergic diseases. The study started with a parental questionnaire to estimate the prevalence of asthma, rhinitis, and eczema, as well as risk factors for these conditions (17). The children in Kiruna and Luleå were invited to undergo skin tests (17). This first survey was performed from February through April 1996. Follow-ups were performed during the same period in 1997 (13) and 1998. The questionnaire was distributed by the teachers to the parents of the children.

The study was approved by the ethical committee at the University of Umeå and the University Hospital of Northern Sweden in Umeå.

Study population

Of the 3525 invited school children aged 7–8 years, 3431 (97%) participated in the first survey in 1996. The response rate was almost identical in the two follow-up surveys, and 3247 children participated in all three surveys, which corresponds to 92% of all of those invited in 1996 (Table 1).

Questionnaire

The core questions from the ISAAC questionnaire (20) about asthma and wheezing, rhinitis, and eczema were used. The ISAAC questionnaire included questions about ever asthma, ever wheeze, wheezing during the last 12 months, frequency and severity of wheeze. In addition to the ISAAC questions, questions about physician-diagnosed diseases, use of medicines, family history of asthma or allergic diseases, exposure to possible risk factors such as past or present pets at home, parental smoking, house dampness, and other factors in childhood, were added (17). The same questionnaire regarding symptoms, diseases, morbidity, and current exposures were used in the follow-ups. Respiratory infection was defined as a history of whooping cough, croup, pneumonia, or severe respiratory infection including respiratory syncytial virus.

Skin-prick test

Of the 2454 invited children 2149 or 88% participated. Testing was performed by Lancet on the forearm with a single test for each of 10 allergens. The following allergens (ALK, Denmark) were included: birch, timothy, mugwort, cat, dog, horse, *D. pteronyssinus*, *D. farinae*, *Cladosporium*, and *Alternaria*. Histamine 10 ng/ml was used as positive control and glycerol as negative control. The test was considered positive if the mean wheal diameter was 3 mm or more.

Definitions

Asthma was surveyed in the questionnaire by two separate questions:

Ever asthma: "Has your child ever had asthma?"
Physician-diagnosed asthma: "Has your child been diagnosed by a physician as having asthma?"
Current asthma: Physician-diagnosed asthma *and* either symptoms related to asthma or use of asthma medicines during the last 12 months.
Use of asthma medicines: Determined by the question—"How often has the child used asthma medicines during the last 12 months?" The alternatives were: *never*, *sometimes*, *frequently/periodically*, or *daily*.

Wheeze was surveyed as follows:

Ever wheeze: "Has your child had wheezing or whistling in the chest at any time in the past?"
Wheezing during the last 12 months: "Has your child had wheezing or whistling in the chest in the last 12 months?"
Type I allergy: At least one positive skin test.

Statistical analyses

The prevalence was calculated from all responders each year. The calculations of the incidence of asthma, wheezing, and use of asthma medicines were based on those who participated in all three surveys.

Table I. The number of children who were invited and who participated in 1996, and the number of children who participated in 1996, 1997, and 1998 by area and sex

Cohort	Study year		Kiruna	Luleå	Piteå	Boys	Girls	All
Invited	1996	*n*	680	1774	1071	1797	1728	3525
Participated	1996	*n*	671	1757	1003	1750	1681	3431
		(%)	(99%)	(99%)	(94%)	(97%)	(97%)	(97%)
Participated	1996, 1997, and 1998	*n*	634	1658	955	1653	1594	3247
		(%)[a]	(95%)	(94%)	(95%)	(95%)	(95%)	(95%)

[a]Percentage reflects the proportion of children participating in both 1997 and 1998 of those participated in 1996.

The incidence has been expressed as the proportion of the children without the studied condition in 1996 who developed the condition during the 2-year period under study. Three categories of incidence of asthma were estimated: ever asthma, physician-diagnosed asthma, and current asthma.

The question about physician-diagnosed asthma in the 1996 survey had been validated by paediatricians (11). The children who were classified as having asthma or having had asthma at these examinations, and the children with questionnaire based physician-diagnosed asthma or ever asthma according to the 1996 questionnaire were excluded from the population at risk when the incidence of asthma was calculated.

The incidence of wheezing was calculated among the children who did not answer "yes" to the questions about ever wheeze or wheezing during the last 12 months in the 1996 survey, and in 1997 or 1998 reported wheezing during the last 12 months. The incidence of *users of asthma medicines* was estimated from the children without any use of asthma medicines in 1996. Pearson's chi-square test was used to compare the prevalence and incidence between boys and girls and as well as between the study years.

Data about risk factors were collected in the 1996 survey, i.e. before the onset of the disease. Risk ratios (RR) with the corresponding 95% confidence intervals were calculated for determinants of incident asthma and wheezing, respectively. Multiple logistic regression analysis was performed for variables that were significantly associated with asthma or wheezing by univariate analysis. In addition, risk factors that in earlier studies of the cohort were significantly associated with prevalent asthma were included; past or present mother's smoking, breastfeeding ≤ 3 months, and ever having cat, dog, or other pets at home. As dependent variables, ever asthma and wheezing during the last 12 months, were selected. The variable ever asthma was chosen as it reached higher power than the variable physician-diagnosed asthma, or current asthma.

RESULTS

Prevalence

The prevalence of ever asthma and physician-diagnosed asthma increased during the two years; physician-diagnosed asthma increased from 5.7 to 7.1% ($P < 0.001$). The prevalence of wheezing during the last 12 months did not increase, in fact the prevalence of wheezing declined from 11.7 to 10.2% ($P = 0.045$) (Table 2).

An increase of children using any asthma medicines was seen during the first year but not the second year. The prevalence of the children who reported frequent

TABLE 2. Prevalence (%) of asthma and other asthma conditions in 1996, 1997, and 1998. Difference (*P*-value) by gender and study year 1996 *vs.* 1998

	Study year	Boys	Girls	All	*P*-value by	
					Sex	Year 1996–1998
Ever asthma	1996	7.8	4.9	6.4	<0.001	
	1997	9.4	6.0	7.7	<0.001	
	1998	11.1	6.6	8.9	<0.001	<0.001
Physician-diagnosed asthma	1996	7.1	4.3	5.7	<0.001	
	1997	7.9	5.0	6.5	0.001	
	1998	8.9	5.4	7.1	<0.001	0.024
Current asthma	1996	6.5	4.2	5.3	0.002	
	1997	6.9	4.5	5.7	0.003	
	1998	7.5	4.4	6.0	<0.001	0.247
Use of asthma medicines during the last 12 months						
Any asthma medicines	1996	8.1	6.0	7.1	0.019	
	1997	11.1	8.4	9.8	0.005	
	1998	11.6	7.3	9.5	<0.001	<0.001
Frequent use of asthma medicines	1996	3.9	2.9	3.4	0.079	
	1997	4.0	3.7	3.9	0.530	
	1998	4.2	3.0	3.6	0.064	0.673
Wheezing during the last 12 months	1996	12.9	10.4	11.7	0.016	
	1997	12.0	9.3	10.7	0.009	
	1998	12.0	8.2	10.2	<0.001	0.045

Table 3. Annual incidence in percent, and number (*n*) of incident cases of asthma, and other asthma conditions between 1996 and 1997, and 1997 and 1998, and cumulative incidence (%) 1996–1998 of the same conditions. Difference (*P*-value) by gender

Condition	Study period	Boys	Girls	All	Difference (*P*-value)* by sex
		% (*n*)	% (*n*)	% (*n*)	
Ever asthma	1996–1997	1.6 (24)	1.2 (18)	1.4 (42)	0.657
	1997–1998	2.3 (33)	1.1 (16)	1.7 (49)	0.031
	1996–1998	3.8 (57)	2.3 (34)	3.1 (91)	0.015
Physician-diagnosed asthma	1996–1997	1.1 (16)	0.7 (11)	0.9 (27)	0.586
	1997–1998	1.1 (16)	0.5 (8)	0.8 (24)	0.254
	1996–1998	2.1 (32)	1.3 (19)	1.7 (51)	0.069
Current asthma	1996–1997	0.9 (14)	0.7 (11)	0.8 (25)	0.712
	1997–1998	1.1 (16)	0.4 (6)	0.8 (22)	0.033
	1996–1998	2.1 (30)	1.2 (17)	1.6 (47)	0.059
Wheezing during the last 12 months	1996–1997	4.3 (53)	2.9 (37)	3.8 (90)	0.049
	1997–1998	3.4 (40)	2.3 (29)	2.8 (69)	0.102
	1996–1998	7.6 (93)	5.1 (66)	6.3 (159)	0.010
Frequent use of asthma medicines[a]	1996–1997	1.0 (14)	1.1 (16)	1.1 (30)	0.242
	1997–1998	1.3 (17)	0.7 (10)	1.0 (27)	0.178
	1996–1998	2.3 (31)	1.9 (26)	2.1 (57)	0.505

[a]Subjects with any use of asthma medicines prior to the year under study have been excluded when analysing the incidence.
*Chi-square test.

use of asthma medicines was similar in all 3 years. This was also true for the use of inhaled corticosteroids, used by 4.3% of the children in both 1996 and 1998. The prevalence of each of the different measures of asthma, as well as of wheezing and any use of asthma medicines, were all significantly higher among boys (Table 2).

Incidence

The cumulative incidence of physician-diagnosed asthma during the 2 years was 1.7%. The incident rate was 0.9/100/year the first year and 0.8/100/year during the second year. The incidence of current asthma was similar, while the incidence of ever asthma was 3.1%, and significantly higher among boys (Table 3).

The cumulative incidence of wheezing and new users of any asthma medicines were similar, 6.3 and 7.4%, respectively, while the incidence of frequent or daily users of asthma medicines was 2.1%. These incidence rates were slightly higher the first year than the second year, QJ;however, not significantly (Table 3).

Of the 51 incident cases of physician-diagnosed asthma, 64.7% reported current wheezing, 80.4% use of asthma medicines, and 31.4% use of inhaled corticosteriods in 1998. None of the 51 incident cases had used asthma medicines in 1996 while 15 children had reported ever wheeze in 1996. For six children, wheezing had been present prior to the year they reported a diagnose of asthma; however, for all of them wheezing had occurred fewer than four times during the year (Table 4).

Risk factors for incident cases of asthma and wheezing, univariate analysis

The most important risk factors for incident cases of ever asthma were a positive skin test, RR 5.32 (3.19–8.87), rhinitis RR 3.66 (2.13–6.31), and ezcema, RR 2.75 (1.73–4.38), and a history of asthma in the family, RR 2.87 (1.92–4.36). Other significant risk factors were male sex RR 1.67 (1.10–2.54), a birth weight < 2500 g, RR 2.67 (1.37–5.18), and respiratory infections in childhood, RR 2.10 (1.30–3.38) (Table 5).

The risk factor pattern for incident cases of physician-diagnosed asthma was similar, but a diagnosis of rhinitis showed the highest risk, RR 6.12 (3.28–11.41). Short time of breast feeding, birth order, having a smoking mother, pets at home, or dampness at home had no significant influence on either ever asthma or physician-diagnosed asthma (Table 5).

A positive skin test, RR 3.21 (2.23–4.63), was also the most important risk factor for the incidence of wheezing, and a report of past or present dampness at home was a significant risk factor (Table 5).

Risk factors for incident cases of asthma, multivariate analysis

In the multivariate analysis, the results remained similar to those seen with the univariate analysis with a few exceptions. When including the variable positive skin test in the analysis male sex and low birth weight were no longer significant risk factors for incident ever asthma, while a smoking mother became a significant risk factor, OR

Table 4. Report of symptoms and use of asthma medicines in 1996 (before onset), and 1998 (after onset,) among the children with incident physician-diagnosed asthma and ever asthma

		Physician-diagnosed asthma (n=51)		Ever asthma (n=91)	
Clinical signs		1996	1998	1996	1998
Ever wheeze	*n* (%)	15 (29.4)	39 (76.5)	39 (42.9)	72 (79.1)
Wheezing last 12 months	*n* (%)	6 (11.8)	33 (64.7)	18 (19.8)	43 (47.3)
1–3 times/last 12 months	*n*	6	19	17	25
4–12 times/last 12 months	*n*	0	10	0	13
> 12 times/last 12 months	*n*	0	4	1	5
Sleep disturbance	*n* (%)	3 (5.9)	8 (15.7)	0	12 (13.2)
< 1 night per week	*n*	3	6	0	8
⩾ 1 night or more per week	*n*	0	2	0	4
Use of any asthma medicines	*n* (%)	0	41 (80.4)	3 (3.3)	52 (57.1)
Sometimes	*n*	0	23	3	32
Often/periodical	*n*	0	12	0	13
Daily	*n*	0	6	0	7
Use of inhaled corticosteroids	*n* (%)	0	16 (31.4)	0	18 (19.8)

Table 5. Risk factors (RR) for incident cases of asthma and physician-diagnosed asthma. Prevalence of the risk factors among the population under risk for developing asthma

		Dependent variables		
	%	Physician diagnosed asthma RR (95% CI)	Ever asthma RR (95% CI)	Wheezing RR (95% CI)
Male sex	50.1	1.68 (0.95–2.94)	1.67 (1.10–2.54)	1.46 (1.08–1.98)
Positive skin test	17.8	4.88 (2.54–9.97)	5.32 (3.19–8.87)	3.21 (2.23–4.63)
Family history of asthma	21.5	2.56 (1.48–4.44)	2.87 (1.92–4.30)	2.14 (1.57–2.91)
Respiratory infections	58.1	1.70 (0.91–3.16)	2.10 (1.30–3.38)	1.18 (0.86–1.62)
Birth weight < 2500 g	4.0	1.53 (0.48–4.85)	2.67 (1.37–5.18)	1.18 (0.54–2.58)
Breastfeeding ⩽ 3months	24.4	0.61 (0.28–1.28)	0.68 (0.40–1.16)	1.05 (0.74–1.48)
Birth order				
Second	35.8	1.04 (0.54–2.00)	1.10 (0.67–1.79)	0.89 (0.61–1.29)
Third, or more	24.9	1.32 (0.67–2.60)	1.38 (0.83–2.29)	1.36 (0.94–1.96)
Mother smoker	30.6	0.66 (0.34–1.28)	1.12 (0.72–1.73)	1.26 (0.92–1.73)
Pets ever at home	72.7	0.82 (0.46–1.47)	0.89 (0.57–1.38)	1.12 (0.79–1.60)
Dampness at home	16.1	1.17 (0.58–2.40)	1.36 (0.82–2.26)	1.49 (1.03–2.17)
Rhinitis	4.8	6.12 (3.28–11.41)	3.66 (2.13–6.31)	2.49 (1.52–4.08)
Eczema	11.9	3.05 (1.66–5.63)	2.75 (1.73–4.38)	1.86 (1.27–2.73)

2.00 (1.07–3.73) (Table 6). When using the incident cases of physician-diagnosed asthma as the dependent variable the result were similar, however, a smoking mother did not reach significance (data not shown).

When the variable, a positive skin test, was excluded from the analysis, and instead the variables, rhinitis and eczema, were used, rhinitis appeared as the highest risk factor for ever asthma, OR 3.53 (1.80–6.90), as well as for physician-diagnosed asthma OR 5.91 (2.76–12.65). In addition, a family history of asthma, OR 2.83 (1.75–4.56), eczema OR 2.19 (1.26–3.82), respiratory infections, OR 2.12 (1.24–3.63), male sex, OR 1.73 (1.06–2.81), and a birth weight < 2500 g, OR 3.38 (1.61–7.54) were significant risk factors for ever asthma (Table 6).

When all the three variables, positive skin test, rhinitis, and eczema, were included in the analyses, positive skin test showed the highest odds ratios for incident ever asthma, OR 5.15 (2.61–10.15). Eczema remained as a significant risk factor, OR 2.09 (1.02–4.29), while rhinitis was no longer a significant risk factor.

Fewer significant risk factors were found for incident wheezing than for asthma. The significant risk factors were positive skin test, a family history of asthma, rhinitis, eczema, and male sex.

Table 6. Risk factors for incident cases of ever asthma, and wheezing during 1996–1998. Odds ratios (OR) were calculated by multiple logistic regression analysis

Independent variables	Ever asthma[a] OR (95% CI)	Wheezing[a] OR (95% CI)	Ever asthma OR (95% CI)	Wheezing OR (95% CI)
Male sex	1.80 (0.97–3.45)	1.44 (0.93–2.24)	1.73 (1.06–2.81)	1.61 (1.12–2.34)
Family history of asthma	2.82 (1.54–5.14)	2.96 (1.90–4.62)	2.83 (1.75–4.56)	2.57 (1.77–3.74)
Respiratory infections	2.53 (1.28–5.00)	1.30 (0.84–2.03)	2.12 (1.24–3.63)	1.29 (0.90–1.87)
Birth weight <2500 g	2.28 (0.76–6.89)	1.13 (0.34–3.79)	3.38 (1.61–7.54)	0.92 (0.32–2.60)
Breastfeeding ≤ 3 months	0.76 (0.31–1.90)	0.98 (0.58–1.67)	0.46 (0.20–1.04)	1.13 (0.74–1.71)
Mother smoker	2.00 (1.07–3.73)	1.49 (0.93–2.37)	1.36 (0.82–2.25)	1.42 (0.97–2.09)
Pets ever at home	0.74 (0.39–1.38)	1.34 (0.81–2.23)	0.89 (0.54–1.48)	1.23 (0.80–1.88)
Dampness at home	0.73 (0.33–1.61)	1.35 (0.81–2.25)	1.13 (0.63–2.03)	1.25 (0.79–1.96)
Positive skin test	5.64 (3.10-10.25)	3.59 (2.27–5.67)	—	—
Rhinitis	—		3.53 (1.80–6.90)	2.35 (1.25–4.42)
Eczema	—		2.19 (1.26–3.82)	1.88 (1.17–3.04)

[a]The analyses were based on the 2/3 of the cohort who were skin tested.

Pets at home and asthma

A significant negative relationship was found between prevalent cases of physician- diagnosed asthma in 1998 and ever having had a cat at home, RR 0.53 (0.38–0.73). A similar trend was found for incident cases of physician-diagnosed asthma and wheezing; however, these associations were not significant, RR 0.67 (0.35–1.27), and RR 0.82 (0.63–1.06). The result remained significant for prevalent cases in the multivariate analysis, OR 0.62 (0.44–0.87), and borderline significant if the variable positive skin test was included in the analysis, OR 0.67 (0.43–1.04). The association with dog was also negative, but less significant than for cat.

DISCUSSION

This study concludes that the incidence of asthma during 2 years after age 7 is high in comparison to the prevalence. Further, the study illustrates that other factors than allergy are important determinants for the development of asthma in these ages of school children. The results are based on the 3247 children who had participated in three yearly surveys, which started in 1996. The high participation rate in all three surveys, 92% of invited to the first survey, support the validity of the results.

The prevalence of asthma in the cohort increased slightly, however significantly, from 1996 to 1998. The use of asthma medicines increased significantly the first year and remained on a similar level the second year. The increased use of asthma medicines the first year may in part be an effect of the validation study performed after the first survey, when several children were identified as having asthma and received appropriate treatment (11). The incidence of physician-diagnosed asthma and ever asthma, however, was not affected by the validation study. All asthma variables were more prevalent among boys, a result in accordance with other studies in corresponding ages (4–7).

The incidence of physician-diagnosed asthma showed a slightly decreasing trend, 0.9/100/year the first year and 0.8/100/year the second. The size of the incidence rate is similar as in the Tucson studies from the 1970s and 1980s (5), but higher than Broder *et al.* found during the 1960s (4). In England, an incidence rate of 1.1/100/year was found in similar ages during the 1960s; however, the investigators included both asthma and wheezing conditions in their definition (6). A register study (7) reported an incidence rate less than half that found in our study in similar ages. Two prospective studies in Swedish teenagers have reported incidence rates of more than 1/100/year (8,9).

This study found a high incidence of asthma and wheezing, but the prevalence of current asthma, frequent use of asthma medicines as well as of inhaled corticosteroids during the 3 years remained stable. These results are in accordance with reports of a large out growing of asthma and wheezing in these ages (13,21,22). Further, the incidence of wheezing was highest during the first year, 3.8/100/year, and decreased the second year to 2.8/100/year, indicating that younger children are more likely to start wheeze.

When studying risk factors for a disease, it is important that the specificity of the dependent variable is high (23). This was established for the classification physician-diagnosed asthma in a validation study of the prevalent cases in 1996 (11). In addition, the high proportion of children with incident asthma reporting symptoms or use of asthma medicines support the validity of the diagnosis. Further, only a few of the incident cases reported symptoms in 1996, and none of the incident cases of physician-diagnosed asthma had used asthma medicines before they had been diagnosed as having asthma.

The findings suggest that we have identified new cases of asthma.

Allergy (3,8,11–14), as well as rhinitis (6,15), and eczema (6) are related to asthma, a fact that this study strongly confirms. Rhinitis showed the highest risk, RR 6.12, for physician-diagnosed asthma in the univariate analysis, followed by a positive skin test, RR 4.88. However, after correcting for other variables including a positive skin test, rhinitis was no longer the highest risk. The diagnosis of rhinitis included a strong allergy component, since 75% of children with rhinitis also had a positive skin test (17). Thus, an established allergic disease gives a higher risk for development of asthma than sensitisation itself.

Environmental tobacco smoke (11,16,19) and dampness (11,16,18) are documented as risk factors for asthma. In some studies, dampness at home may be a surrogate variable for mites; however, that is not true in this area of Sweden whose climate is cold and dry. No mites had been found in the homes (24), and only very few children were sensitised to mites or moulds (17,24). Dampness at home was not a significant risk factor for incident asthma or wheezing. A smoking mother, that had been strongly related to prevalent asthma at age 7, still had some influential effect on the variables expressing incident asthma after age 7. These differences from the analysis based on prevalent asthma in ages 7–8 years may relate to exposure, since children of school ages spend less time at home and with their mothers.

Other studies have identified low birth weight as a risk factor for asthma among children (25) and also among adults (26). In this study, low birth weight was associated to incident asthma after age 7, but only 4% of the children had a birth weight < 2500 g, indicating that this is not a major determinant for asthma in this cohort.

The relevance of infections in developing asthma is unclear. An increased risk for asthma as a result of respiratory infections has been reported (12,18). On the other hand, a protective effect for allergy has been reported (12). Children with asthma may be more susceptible to viral and bacterial infections, but in a cross-sectional study model, it may be unclear whether an association between respiratory infections and prevalent asthma reflects cause or effect. The results from this study support the hypothesis that respiratory infections in childhood increase the risk for developing of asthma, since respiratory infections were common in this cohort, and further, they appeared as a significant risk factor for incident asthma. As the data were collected by questionnaire, we do not have objective methods to distinguish between different types of infections.

One reason behind the "hygiene hypothesis", presented by Strachan in 1989, was the finding that many siblings were related with a decreased risk for allergy (27). In this study, no protective effect for asthma was found among those children born second or later in the birth order of the family, which is supported by other studies (28,29).

Finally, the study indicates that having cat at home may protect against getting asthma. One reason behind the result is, of course, an avoidance of animals in families with asthma or allergy. However, the protective effect was seen after correction for asthma in the family (11). A tolerance due to high exposure, or an effect of endotoxin from the pets are under discussion (30). The current discussion about the topic is important and further longitudinal studies are needed.

In conclusion, the incidence of asthma during 2years after age 7 was high, almost 1/100/year. Type-1 allergy was the most important risk factor for asthma, but also other factors were influential; a family history of asthma, rhinitis, eczema, respiratory infections, a smoking mother, and male sex.

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